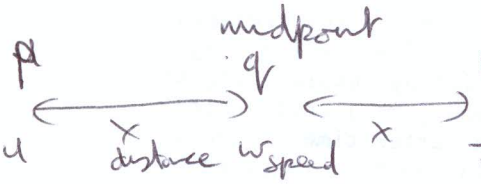
1995 HLC Kinematics Q1

(a)



(i) Region [pq]:

$$w^2 = u^2 + 2ax$$

Region [qr]:

$$(7u)^2 = w^2 + 2ux$$

$$\therefore w^2 - u^2 = 49u^2 - w^2$$

$$2w^2 = 50u^2$$

$$w^2 = 25u^2$$

$$w = 5u \text{ m/s.}$$

(ii) Region [pq]:

$$v = u + at \Rightarrow 5u = u + at_1$$

$$\Rightarrow t_1 = \frac{4u}{a}$$

Region [qr]:

$$v = u + at \qquad \Rightarrow 7u = 5u + at_2$$

$$\Rightarrow t_2 = \frac{2u}{a}$$

$$\therefore \boxed{t_1 = 2t_2} \text{ qed}$$

(b) (i) greatest height for each ball 3m

$u = u$

$a = -9.8 = -g$

$s = 3$

$v = 0$ at greatest height

$$v^2 = u^2 + 2as$$

$$0^2 = u^2 - 2g(3)$$

$$\Rightarrow \boxed{u = \sqrt{6g}}$$

(ii) To have 6 balls in the "air" the gap of t seconds between

$\Rightarrow$ Time in flight $= 6t$

$\Rightarrow$ Time to reach max height $= 3t$

$v = 0$

$u = \sqrt{6g}$

$a = -g$

$t_{time} = 3t$

$v = u + at.$

$0 = \sqrt{6g} - g(3t)$

$$\Rightarrow t = \frac{\sqrt{6g}}{3g} = .26 \text{ seconds}$$

(iii) $h_4 = 3m.$

$h_5 = h_3$

Find h_3: Time $= 2(t) = 2\left(\frac{\sqrt{6g}}{3g}\right)$

$$s = ut + \tfrac{1}{2}at^2 \Rightarrow h_3 = 6g\left(\frac{2\sqrt{6g}}{3g}\right) - \frac{1}{2}g\left(\frac{2\sqrt{6g}}{3g}\right)^2$$

$$\Rightarrow h_3 = 4 - \frac{4}{3}$$

$$\Rightarrow h_3 = \frac{8}{3}$$

Also $\boxed{h_6 = h_2}$

Find h_2 Time $= t = \frac{\sqrt{6g}}{3g}$

$$s = ut + \tfrac{1}{2}at^2 \Rightarrow h_2 = \sqrt{6g}\left(\frac{\sqrt{6g}}{3g}\right) - \frac{1}{2}g\left(\frac{\sqrt{6g}}{3g}\right)^2$$

$$h_2 = 2 - \frac{1}{3}$$

$$h_2 = \frac{5}{3}$$

$\therefore h_4 = 3$ metres $\quad h_1 = 0$

$h_5 = h_3 = \frac{8}{3}$ metres

$h_2 = h_6 = \frac{5}{3}$ metres